Q1 : Choose the best answer **[5 Marks]**

1- What is the carrier frequency if both used frequencies in BFSK are f_1=200 kHz and f_2=300 kHz

a. 100 kHz

b. 200 kHz

c. 250 kHz

d. 300 kHz

2- Find the minimum hamming distance for correcting 2 errors

a. $d_{min} = 2$

b. $d_{min} = 3$

c. $d_{min} = 5$

d. $d_{min} = 7$

3- In MASK system with each amplitude represents 4 bits, the system has ..... levels.

a. 4

b. 8

c. 16

d. 34

4- In delta modulation increasing the size of the step (σ) will .

a. Increase quantization noise

b Increase slope overload noise

c. decrease quantization noise

d. both a and b

5- A system hamming codes to send hexadecimal digits (0 – F), using the equations in Q4, what will be the syndrome for a received codeword that shows the dataword is '2' instead of 'A'?

a. S = (0 , 1 , 1)

b S = (1 , 0 , 0)

c. S = (1 , 0, 1)

d. S = (1 , 1 , 0)

Q2 : Short answers

[6 Marks]

a- List the three characteristics of analog wave

1- Amplitude
2- Frequency
3- phase

b- In synchronous transmission (long stream of bits), how can both transmission ends synchronize?

1- Embedded sync within the coding.
2- Separate clock line for sync.

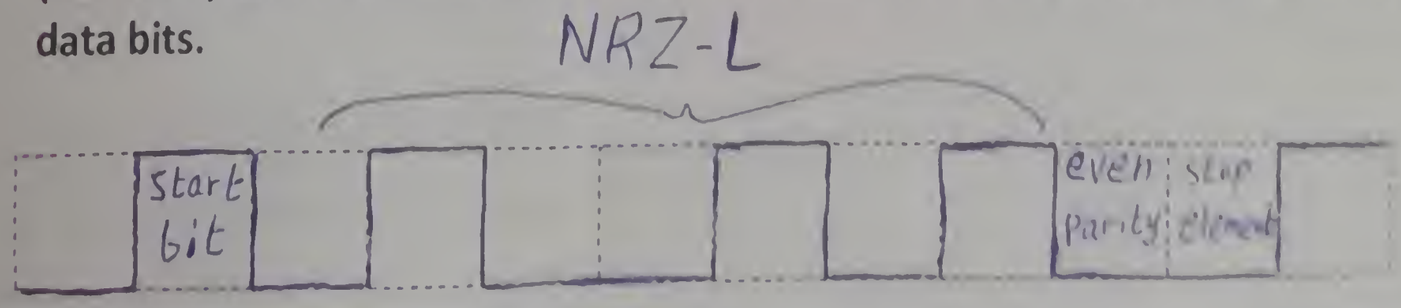
c- What are the two reasons for modulating analog data into analog signal?

1- Higher frequency can give more efficient transmission
2- Permits frequency division multiplexing

d- What is the PCM code for the following set of PAM values 1.7, 5.2, 10.3, and 2.9 (the system has 16 levels).

PAM 1.7 5.2 10.3 2.9
PCM 1 5 10 2
Encoded 0001 0101 1010 0010

e- Draw the Asynchronous signal used to send the following block of bits as the data (1011010) with the assumption that even parity is used; draw all the control and data bits.



Q3 : Cyclic Redundancy Check [9 Marks]

a- For the dataword (D = 11010101) and CRC with polynomial x^3+x^2+1 as the generator, calculate the codeword (use the binary method) 1101

$n-k+1=4 \rightarrow n-k=3$

```
      10000110
    ------------
1101 | 11010101000
       1101
       ----
        0000
        0000
        ----
         0001
         0000
         ----
          0010
          0000
          ----
           0101
           0000
           ----
            1010
            1101
            ----
             1110
             1101
             ----
              0110
              0000
              ----
               110
```

Code word = 11010101110

b- For the codeword (C = 101001110101) with a divisor (P = 10111), what are the values of k, n and r? And is the codeword correct? (use the polynomial method and show your work)

$n-k+1=5 \rightarrow n-k=4$

$n=12 \rightarrow 12-k=4$

$k=8$, $r=4$

$C = X^{11}+X^9+X^6+X^5+X^4+X^2+1$

$P = X^4+X^2+X+1$

The code word isn't Correct

$$
\begin{array}{r|l}
X^4+X^2+X+1 & X^{11}+X^9+X^6+X^5+X^4+X^2+1 \\
 & X^{11}+X^9+X^8+X^7 \\
\hline
 & X^8+X^7+X^6+X^5 \\
 & X^8+X^6+X^5+X^4 \\
\hline
 & X^7+X^4+X^4+X^2 \\
 & X^7+X^5+X^4+X^2 \\
\hline
 & X^5+X^4+X^2+X^2 \\
 & X^5+X^3+X^2+X \\
\hline
 & X^4+X+1 \\
 & X^4+X^2+X+1 \\
\hline
 & X^2
\end{array}
$$

$$d_0 \oplus d_1 \oplus d_3 = p_0$$
$$d_0 \oplus d_2 \oplus d_3 = p_1$$
$$d_1 \oplus d_2 \oplus d_3 = p_2$$

a- Using the equations method, find and fix (if there is) the error for the following codewords (C1 = 1011001, C2 = 0001111).

$C_1 = 1011001$ ($d_0\ d_1\ d_2\ d_3\ P_0\ P_1\ P_2$)

$S_0 = d_0 \oplus d_1 \oplus d_3 \oplus P_0$

$S_0 = 1 \oplus 0 \oplus 1 \oplus 0 = 0$

$S_1 = d_0 \oplus d_2 \oplus d_3 \oplus P_1$

$S_1 = 1 \oplus 1 \oplus 1 \oplus 0 = 1$

$S_2 = d_1 \oplus d_2 \oplus d_3 \oplus P_2$

$S_2 = 0 \oplus 1 \oplus 1 \oplus 1 = 1$

$S = 110$; the error in d_2

$C_1 = 1001001$

$C_2 = 0000111$ ($d_0\ d_1\ d_2\ d_3\ P_0\ P_1\ P_2$)

$S_0 = d_0 \oplus d_1 \oplus d_3 \oplus P_0$

$S_0 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$

$S_1 = d_0 \oplus d_2 \oplus d_3 \oplus P_1$

$S_1 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$

$S_2 = d_1 \oplus d_2 \oplus d_3 \oplus P_2$

$S_2 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$

$S = 000$; there is no error

b- Using the equations method, generate the codeword for the dataword (D = 1101)

$P_0 = d_0 \oplus d_1 \oplus d_3 \Rightarrow 1 \oplus 1 \oplus 1 = 1$

$P_1 = d_0 \oplus d_2 \oplus d_3 \Rightarrow 1 \oplus 0 \oplus 1 = 0$

$P_2 = d_1 \oplus d_2 \oplus d_3 \Rightarrow 1 \oplus 0 \oplus 1 = 0$

$C = 1101100$

c- For the Hamming code system C(15, 11) find k, n, r, and dmin

$n = 2^m - 1$; $n = 15$, $k = 11$

$r = m$; $n - k = r$

$r = 15 - 11 = 4$

for checking $\rightarrow n = 2^4 - 1 = 15$

& $15 = 2^m - 1 \rightarrow m = 4$